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ZPR-I-Memo--427

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To: ZPR-I Distribution (Limited)

From: S.B. Brumbach SBB ZPPR-13 Assembly Coordinator

Subject: Detailed Work Plan No. 16: Control Rod Worth Measurements in ZPPR-13B/1

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ZPPR Assembly 13
Detailed Work Plan No. 16
Control Rod Worth Measurements in ZPPR-13B/1

All experiments and/or geometry changes described herein are subject to safety review and approval by the Reactor Manager. Additional measurements may be added at his request to satisfy safety or operational requirements.

I. Introduction

The broken-cylindrical-blanket configuration of ZPPR-13, designated ZPPR-13B/1, will be used to measure the worths of an extensive set of mockup control rods. Two basic sets of measurements are planned, one in which two-by-two drawer control rods will be substituted for fuel, and one in which two-by-three drawer control rods or control rod positions are substituted for fuel.

II. Reactor Configuration

Measurements will be performed in the ZPPR-13B/1 reference subcritical configuration modified by moving six detector drawers. These detectors are moved because they are in areas which will be occupied by control rods some time during the experiment. Detectors are moved to the nearest location of a similar drawer type (single-column fuel or double-column fuel). The detector in location 162-57 should be moved to 162-58. The detector in location 156-63 should be moved to 155-63. The detector in location 168-39 should be moved to 169-39. The detector in location 138-69 should be moved to 137-70. The detector in location 138-33 should be moved to 138-32. The detector in location 243-56 should be moved to 244-55. All 64 detectors should be used.

III. Control Rod Drawers and Control Rod Position Drawers

The control-rod position drawers are filled with sodium cans for their entire 36-in. length. Control rod drawers are filled with natural B_4C plates for their first 18 in. and are filled with sodium cans from 18 to 36 in. All control rods and control rod positions occupy both half 1 and half 2.

III. Measurement Sequence

Measurements in Steps 2-19 use rod locations shown in Fig. 1. Measurements in Steps 20-30 use rod locations shown in Fig. 2.

Step 1: Use the SIXTY4 program and a rod drop to establish the subcriticality of the reference configuration.

Step 2: Remove fuel drawers from the locations included in CR #6. Replace the fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 3: Remove fuel drawers from the locations included in CRs 2,3,4,5 and 7. Replace the fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 4: Remove fuel drawers from the locations included in CRs 8,10,12,14,16 and 18. Replace the fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 5: Remove the boron-containing drawers from rod locations 8,10,12,14,16 and 18 and put back the original fuel drawers. Remove the fuel drawers from rod locations 20,22,24,26,28 and 30. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 6: Remove the boron-containing drawers from rod locations 20,22,24,26,28 and 30 and put back the original fuel drawers. Remove the fuel drawers from rod locations 21,23,25,27,29 and 31. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 7: Remove the boron-containing drawers from rod locations 2,3,4,5,6 and 7 and put back the original fuel drawers. Measure the subcriticality of this configuration.

Step 8: Remove the fuel drawers from rod locations 8,10,12,14,16 and 18. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 9: Remove the boron-containing drawers from rod locations 8,10,12,14, 16 and 18 and put back the original fuel drawers. Remove the fuel drawers from rod locations 22,24,26,28,30 and 31. Replace these fuel drawers with boron-containing drawers and measure the sub-criticality of this configuration.

Step 10: Remove the boron-containing drawers from rod locations 21,23,25,27, 29 and 31 and put back the original fuel drawers. Measure the sub-criticality of this configuration.

Step 11: Remove the fuel drawers from rod locations 8,10,12,14,16 and 18. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 12: Remove the boron-containing drawers from rod locations 20,22,24,26,28 and 30 and put back the original fuel drawers. Measure the sub-criticality of this configuration.

Step 13: Remove the fuel drawers from rod locations 9,11,13,15,17 and 19. Replace these fuel drawers with boron-containing drawers and measure the sub-criticality of this configuration.

Step 14: Remove the boron-containing drawers from rod locations 8,10,12,14, 16 and 18 and put back the original fuel drawers. Measure the sub-criticality of this configuration.

Step 15: Remove the boron-containing drawers from rod locations 9,11,13,15,17 and 19 and put back the original fuel drawers. Remove the fuel drawers from rod location 16. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 16 Remove the boron-containing drawers from rod location 16 and put back the original fuel drawers. Remove the fuel drawers from rod location 28. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 17: Remove the boron-containing drawers from rod location 28 and put back the original fuel drawers. Remove the fuel drawers from rod location 25. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 18: Remove the boron-containing drawers from rod location 25 and put back the original fuel drawers. Remove the fuel drawers from rod location 22. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 19: Remove the boron-containing drawers from rod location 22 and put back the original fuel drawers. Remove the fuel drawers from rod location 31. Replace these fuel drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 20: Remove the boron-containing drawers from rod location 31 and put back the original fuel drawers. Remove the fuel drawers from rod location 16I. Replace these fuel drawers with sodium-containing drawers and measure the subcriticality of this configuration.

Step 21: Remove the fuel drawers from rod locations 8I,10I,12I,14I and 18I. Replace these fuel drawers with sodium-containing drawers and measure the subcriticality of this configuration.

Step 22: Remove the sodium-containing drawers from rod locations 8I,10I,12I,14I, 16I and 18I. Replace these sodium-containing drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 23: Remove the boron-containing drawers from rod locations 8I,10I,12I,14I and 18I and put back the original fuel drawers. Measure the subcriticality of this configuration.

Step 24: Remove the boron-containing drawers from rod location 16I and put back the original fuel drawers. Remove the fuel drawers from rod locations 8,10,12,14,16 and 18 (2 x 3 drawers). Replace these fuel drawers with sodium-containing drawers and measure the subcriticality of this configuration.

Step 25: Remove the sodium-containing drawers from rod locations 8,10,12,14,16 and 18 (2 x 3 drawers) and replace with boron-containing drawers and measure the subcriticality of this configuration.

Step 26: Remove the boron-containing drawers from rod locations 8,10,12,14,16 and 18 and put back the original fuel drawers. Remove the fuel drawers from rod location 16Ø and replace these fuel drawers with sodium-containing drawers and measure the subcriticality of this configuration.

Step 27: Remove the fuel drawers from rod locations 8Ø,10Ø,12Ø,14Ø and 18Ø. Replace these fuel drawers with sodium-containing drawers and measure the subcriticality of this configuration.

Step 28: Remove the sodium-containing drawers from rod locations 8Ø,10Ø,12Ø,14Ø, 16Ø and 18Ø. Replace these sodium-containing drawers with boron-containing drawers and measure the subcriticality of this configuration.

Step 29: Remove the boron-containing drawers from rod locations 8Ø,10Ø,12Ø,14Ø and 18Ø and put back the original fuel drawers. Measure the subcriticality of this configuration.

Step 30: Remove the boron-containing drawers from rod location 16Ø and put back the original fuel drawers. Measure the subcriticality of this reference configuration with both the SIXTY4 program and with a rod drop.

IV. Measurement Methods

All subcriticality measurements will be made using the subcritical source multiplication method calibrated by a rod drop. All measurements will be made with all shim rods, and PSRs 30 and 31 fully withdrawn. Wait 10 min after achieving stable power before acquiring data. Count statistics should be within $\pm$ 1%, but count times should not exceed 30 min.

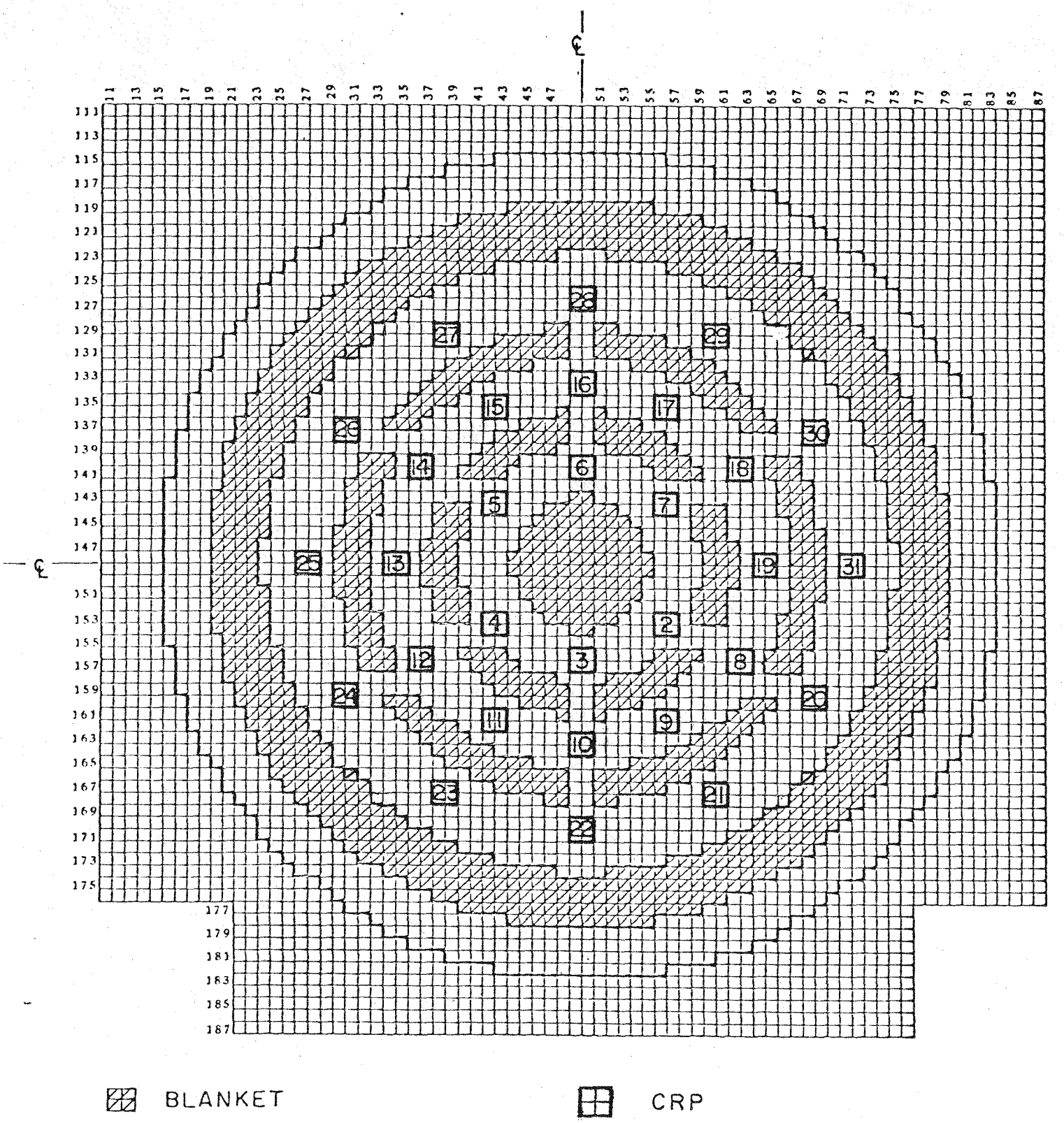

Fig. 1. Two-by-two-drawer-control rod locations in the broken cylindrical blanket configuration of ZPPR-13B.

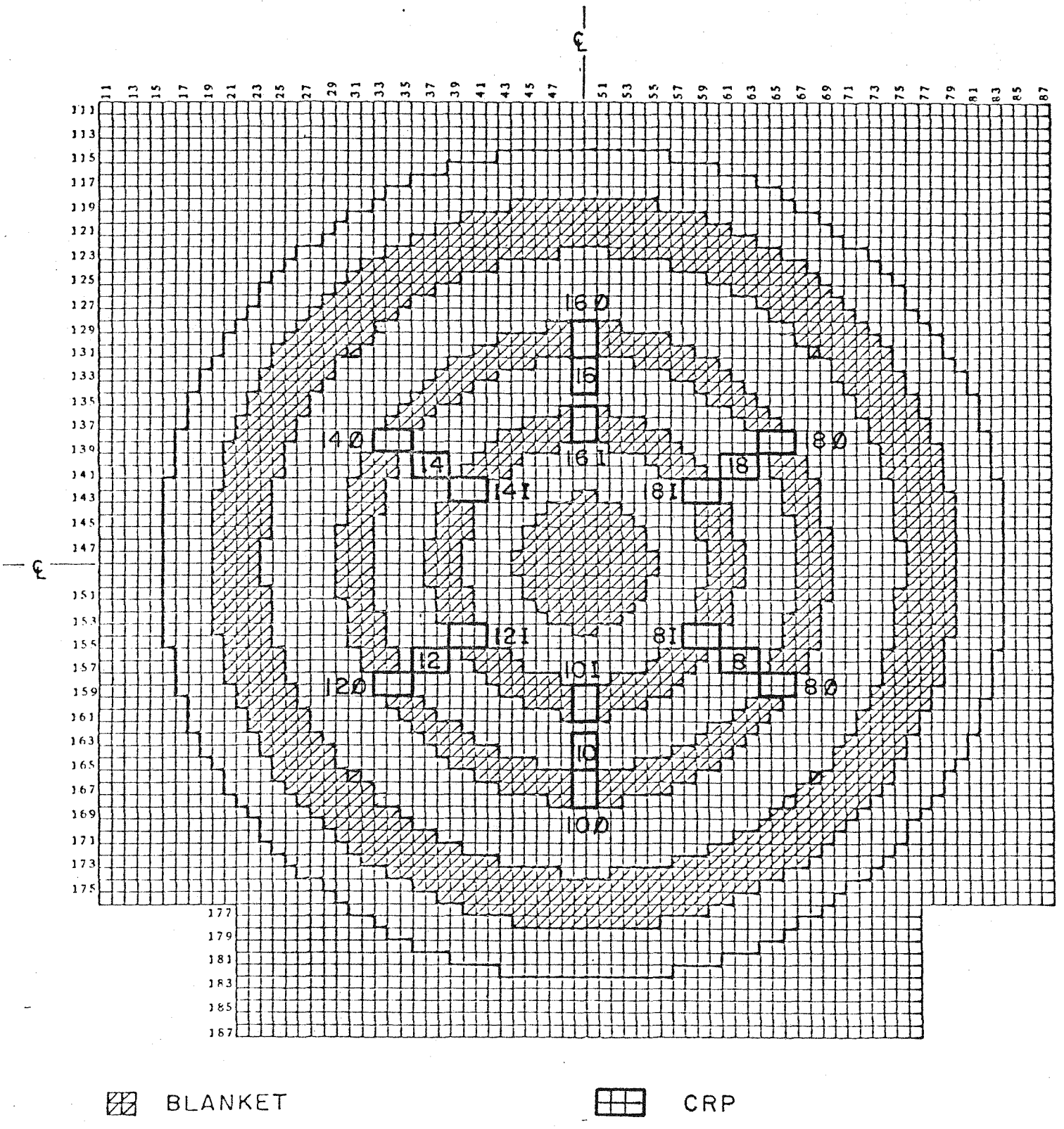

Fig. 2. Three-by-two-drawer-control rod locations in the broken cylindrical blanket configuration of ZPPR-13B.